they may be transplanted to the positions which they are intended to occupy permanently as roadside trees. As, however, the percentage of these large cuttings which will strike is always uncertain, the method is not recommended for general use. But in certain localities where rainfall is adequate the tree cutting mentioned above may be planted in "situ" after few heavy showers at the beginning of the monsoon. If the rains fail it will be necessary to water these cuttings by water cart.

CHAPTER VII

FORMATION OF AVENUES

Only large healthy seedlings to be planted

1. Only the healthiest and best shaped plants in the nursery should be planted along the roadsides. Sturdy young trees are wanted, and the planting out of forced or weakly seedlings must be rigidly prohibited. The young trees to be planted should be from 2 to 4 feet high. In proportion to their age, they should have good, straight, stout, well-developed, clean stems; and every care should be taken, when moving them, to cause as little injury to their roots as possible. The seedlings will usually be ready for planting out when they are from one to two years old. Wherever it is practicable, the plants should be conveyed in their pots or baskets to the roadside where they are to be planted—care being taken to protect them in every way in order to prevent them from flagging at any time. It is best to carry out the planting work during a spell of cloudy or damp weather.

Position of trees in relation to the roadway

2. Trees should never be planted on the very edge of the roadway, as the roots are liable in such cases to burst through the surface, damaging the road and tripping up bullocks and horses. In addition, the shade becomes too dense, and the trunks are dangerously close for passing carts. On the other hand, trees should never be planted on the extreme edge of the land belonging to a road running between cultivated fields as the shade will then injure the crops.

How to align an avenue

3. In planting avenues, it is desirable to begin by laying out the centre line of the road with ½ inch thick rope, correcting any askward curves or bends in order that an improved and fairly easy curvature may be obtained for the avenue. The two side lines should then be measured off from the centre line, and the pits, in which the young trees are to be planted, marked zigzag at the distance apart that has been decided upon. For setting out straight roads, flagged-poles will be found useful.

Range of width of avenues

4. The width of the avenue to be planted will be determined by the class of the road and the height of the embankment above the average ground level. Generally speaking the following widths will be found suitable, *vide* plate II.

(1)	National Highways ...	80 feet
(2)	Provincial Highways ...	80 feet
(3)	Major District Roads ...	50 feet
(4)	Other District Roads ...	30 feet
(5)	Village Roads ...	30 feet

Range of distance apart suggested for different species

5. The distance to be left between each tree in a line will depend chiefly on the species, and partly on the soil and climate. The important point to remember in this connection is not to plant trees too closely. Generally the spacing between the trees should be between 30 and 50 feet.

Remarks regarding the planting of different species in an avenue

6. It is advisable to plant trees of the same species in the same length or section of a new avenue. There is, however, no objection to filling up vacancies in an old avenue of mixed species with young trees of different suitable species.

Preparing pits

7. The pits must be at least of the size required to take in the ball of earth, or the roots, with sufficient space to firm the earth filling between the ball or roots and the sides. And, as

will be explained later, it is advisable to place a good sized gharrah in each pit for economy and efficiency in watering. But, unless the soil is naturally very rich, it is advisable, as will be explained when dealing with the soil for filling the pits, to have a good body of rich soil in the pit to push on the growth of the tree and reduce the period for which maintenance is required. For this reason the pits should be at least 4 feet wide at top and 3 feet wide at bottom and 3 feet deep. In street planting the size may with advantage be increased but a depth of four feet is sufficient. The shape of the pit is immaterial.

8. The pits should be dug as long as possible before the planting is expected to commence, so that the soil taken from them may weather before it is required for filling in again. The upper soil to a depth of about 1 foot from the surface is the best and should alone be used for mixing with the manure for filling near the plant. When digging the pits it should, therefore, be kept on one side for that purpose. In March or April each pit should be half filled with dry leaves which will become saturated on the first fall of rain. In planting the leaves should be drawn away from the middle and the bottom of the hole so as to leave a clear space 3 feet deep by 2 feet in diameter, which should be filled in with prepared soil on the centre of which the tree should be planted. If there is any reason to think that a bed of sheet kankar underlies the pit it should be dug out and removed.

Soil for filling the pits

9. The best soil available should be used. To encourage growth use manure. A cart-load of good manure mixed with the soil in a tree pit, at the commencement of the monsoon, shortly after the cutting or plant has been planted will result in a saving of one year's cost of maintenance. The manured soil will produce a larger tree in one to two years than unmanured soil will produce in three years. The saving of one year's maintenance charges is well worth obtaining at the cost of a cart-load of good manure, especially where the trees have to be protected from cattle or goats, as the cost of maintaining such protection is great. Where manure cannot be obtained at reasonable rates, a cart-load of black soil should be mixed with the soil in the pits in murrum or red soil and one of red in black soil pits.

Providing arrangements for watering

10. Watering charges are the main source of expenditure in tree-planting and can be reduced by providing each tree pit with a sound earthen pot planted as deep as possible in the pit. A country roof tile (not divided in two for roofing purposes) should be inserted into the mouth of the pot to serve as a channel for the water and to prevent earth falling into the pot. The ordinary gurrah holding about two gallons of water, will, when in contact with earth, exude sufficient moisture into the soil in the pit, to keep a sprouted cutting or young plant alive through the dry season. The rate at which water will pass through gurrahs into the earth depends on the nature of the gurrahs and of the climate, also on whether or not the gurrahs are clean and free from earth inside. If the gurrahs are free from cracks or holes through which water can pass, the water will last from 10 to 20 or more days. Since water carts hold from 100 to 200 gallons, a water cart, making two trips per day, will fill from 100 to 200 gurrahs per day, or, allowing 25 per cent loss in cartage, filling gurrahs, etc., will fill 75 to 150 gurrahs per day. The gurrahs must be filled every ten days and one water cart will then serve 750 to 1,500 gurrahs according to the size of the cart; where the source of supply is not far distant the smaller cart will fill the larger number.

11. The best results will be obtained from using gharas rather deeper and narrower than those in ordinary use; a depth of about fifteen inches with a width of eight or nine inches at the widest part has been found suitable. The side of the ghara which will be turned away from the tree may be painted with coal tar before being buried in the ground; this prevents water escaping at a distance from the roots and thus economises the supply. Special shaped gharas and the use of tar are not essential to the system, which should be adopted in all ordinary cases. With this system there is no danger of over-watering and no waste of water and a glance at the ghara will show at once whether the Mali has been neglecting his work. It is advisable to give each Mali a bamboo pipe about 4 feet long or some similar arrangement by which he can direct the water with certainty into the ghara while standing outside the guard. Most kinds of guards suffer a good deal of injury from the constant entrance of the Mali who cannot often be trusted to make this injury good. Gharas which have been in use a year should be examined at the beginning of the hot weather and replaced

if they are broken or if their pores have become choked by mud. (Fig. 7 of plate III.)

The objection to the plan of using gharas is that unless the ghara is moved at intervals, the tree roots are likely to grow lopsided. Another arrangement is sketched in Fig. 8 Plate III. Good earth to which old manure, if possible, has been added, or road silt, dead leaves, etc. is filled in at the bottom of the hole. On this is built up dry stone of the roughest and cheapest description (quarry rubbish, etc.) leaving a cylindrical space in which the seedling is planted, and is surrounded by good soil, and the top is finished off with clean porous material. When the seedling is watered, practically all the water descends evenly all round to the bottom of the dry stone, very little is evaporated from the space and the rootlets are thus induced to grow downwards and thereby protected from drying by the sun. The holes cost a little, but much less than the value of the watering they save and they give the seedling a good start.

Planting the trees

12. The pits should first be well soaked with water and then filled in with the prepared soil to such a depth that, when the soil has settled, the trees will stand at the right level. The trees should be set so that the earth will stand round the stems at about the same height as in the nursery, being not lower on the stems and not much higher.

Level of planting

13. Special attention is necessary to the level of the soil in which the tree is planted. If it is much above the surrounding soil, the danger of injury from drought is increased; while if it is below the surrounding soil, water collects in excess round the young trees and either kills them or injures them more or less permanently. It is essential, therefore, that drainage should be provided where there is any risk of water collecting. The following rules cover all ordinary cases:—

(*a*) Where the land is high and well drained the trees should be planted flush with the surrounding land.

(*b*) Where trees are planted on the side of an embankment, no special precautions are necessary as water can escape down the slopping bank.

(*c*) Where the land is low-lying, the trees should be planted on mounds about one foot high, with a diameter at least three times the height, and sides sloping very gently. If the sides are steep or the mound narrow, heavy rain may wash the earth away and expose the roots of the tree which will then almost certainly die.

(*d*) The tendency to plant trees below the surface of the surrounding soil must be rigorously checked : malis often prefer this system because it saves trouble in watering and careful supervision of this point is, therefore, essential.

14. Only one tree should be planted in each pit : the common practice of planting several trees and subsequently throwing away all but one is not only wasteful but injurious. If the tree, to be planted, has a ball of soil round the roots, this ball may be placed on the filled soil and then more soil filled in and firmly trodden down round it. It is essential that the soil should not separate from the ball as the ball will then dry and the tree die. This should be watched shortly after planting.

15. There should always be two or three planters, one to hold the tree in its proper position with its collar at about the point where the final ground level is to be, the others to shovel in the earth round the tree and tread it firmly in, taking care that it is broken up fine and not in large lumps. The earth should be slightly raised round the stem and lower towards the edge of the hole, so that, when irrigated, the stem may stand in a little island.

16. If any damage has been done to the roots so that their growth has been in any degree checked, it is advisable to cut back or shorten some of the branches and to remove some of the leaves if excessive. This is of greater importance in proportion to the dryness of the air at the time of planting.

Protecting the young trees

17. It is always necessary to keep the young tree steady until the roots have caught hold of the soil, as otherwise the formation and growth of the roots will be prejudicially affected. If stakes are provided for this purpose two should be used for each tree and these should be placed in the line of the prevailing wind. The band or rope should not be tied round the tree but

should touch it for half its circumference only. The bark should be protected from damage by the rope by interposing a piece of cloth. And the stakes and ties should be removed as soon as the tree is steady without their assistance.

18. The young trees must also be protected from damage by goats and cattle, especially the former. If the young trees are kept as advised, in nurseries until they are of such size that goats cannot reach the leaves, thorny branches tied round the stems may be sufficient. This is a considerable advantage as all forms of protection are costly and the loss of efficiency through attempts at economy is probably more costly than any form of protection. The different forms of protection are dealt with fully under fencing in a subsequent chapter to which reference should be made. It is only necessary to point out here that the protection must be maintained in efficient condition until the tree is established.

Watering

19. It cannot be too frequently pointed out that the watering it the most expensive part of raising avenues and every endeavour must be made to reduce its cost by shortening the period for which watering is necessary. When the tree is first planted the soil should be well and thoroughly watered so that it may be moist to the bottom. Thereafter the principle to be kept in view should be to attract the roots towards the bottom of the pits where the natural moisture is greater. This may be done by placing the water in sunken gharas as explained under "Preparing the Pits". If the trees are watered by irrigation from wells or canals which may in some cases be the most economical method, the water should be kept away from the tree and allowed to reach the bottom of the pit by the use of small pits filled with sand to which the water may be admitted from the water-course when required. Watering by head-loads or bhistis' mussocks or hand-carts is always very expensive and usually inefficient. The common practice by which the bhisti dashes water from the mussock or a pail on to the base or collar of the stem should be abandoned, if in use and never adopted. It damages the stem, prevents growth, and keeps the young feeding roots to the surface at the place where least required.